AI-Driven Disruption: Bridging Health Disparities, Preparing for Longevity Shocks, and Exploring Extreme Life Extension

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INTRODUCTION

Artificial intelligence (AI) is driving unprecedented changes in healthcare, influencing not only how diseases are diagnosed and treated but also how longevity is perceived and managed. AI technologies, including machine learning and predictive analytics, enable faster drug discovery, improved diagnostics, and personalized treatment plans. These advancements are reshaping expectations for human health and lifespans, prompting questions about how mortality models should evolve to reflect these rapid changes.

Actuaries have traditionally relied on historical trends and gradual improvements in life expectancy to inform their models. However, AI's capacity to accelerate medical innovation introduces uncertainty that is difficult to quantify using traditional techniques. Breakthroughs in aging research, driven by AI's ability to analyze complex biological datasets, could extend lifespans significantly beyond historical precedents. On the other hand, the integration of AI into healthcare systems introduces risks such as data biases, unequal access, and systemic vulnerabilities that may exacerbate health disparities or, in some scenarios, shorten lives.

This essay explores three areas where AI may impact longevity: reducing health disparities, preparing for longevity shocks, and addressing extreme life extension.

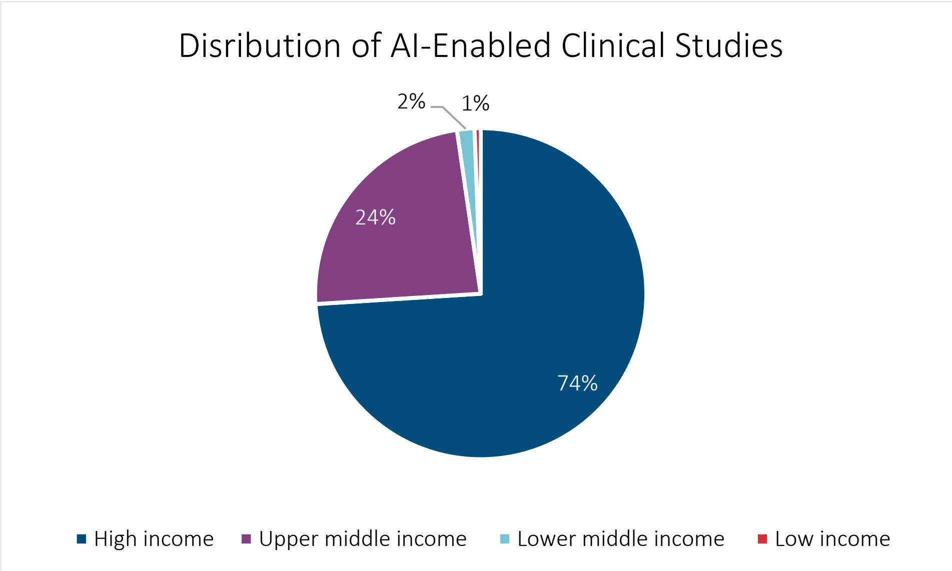
REDUCING HEALTH DISPARITIES THROUGH AI

Health disparities, defined as differences in health outcomes among various population groups, remain a global challenge. Factors such as socioeconomic status, geographic location, and systemic inequities contribute to significant variations in life expectancy. Individuals in high-income countries typically live longer than those in low-income nations, while within countries, racial and ethnic minorities often experience worse health outcomes due to barriers in accessing quality care.

AI offers promising solutions to address these disparities. However, the implementation and impact of AI-driven healthcare innovations remain uneven across different income levels. Yang et al. (2024) analyzed 159 AI-enabled clinical studies finding the disparity by income level as illustrated in Figure 1.

Figure 1

DISTRIBUTION OF AI-ENABLED CLINICAL STUDIES BY INCOME LEVEL OF COUNTRIES



It highlights the concentration of AI healthcare research and applications in wealthier regions, emphasizing the need for strategies to extend these innovations and applications to underserved areas.

Diagnostic tools powered by AI can be used to enhance accuracy and accessibility, particularly in underserved regions. For example, studies have shown that AI-based tools consistently outperform human doctors in diagnosing certain conditions, as listed in Table 1.

Table 1

SAMPLE COMPARISON OF HUMAN AND AI MEDICAL DIAGNOSTIC ACCURACY

Condition	Human Doctor Accuracy (%)	AI Accuracy (%)	Source
Prostate Cancer	67	84	UCLA Study discussed in Heady (2024)
Skin Cancer	75	90	Topol (2019)
Diabetic Retinopathy	85	92	Xu (2023)

These advancements enable earlier and more precise interventions, improving outcomes for populations with limited access to specialists. In addition, as discussed in Topol (2019), telemedicine platforms that leverage AI for triaging patients and recommending treatments have increased healthcare access in rural and low-resource settings.

Personalized medicine is another transformative application of AI. By analyzing genetic, environmental, and lifestyle data, AI can tailor treatments to individual patients. This is particularly important in managing chronic conditions such as diabetes and cardiovascular disease, which disproportionately affect marginalized populations. Tailored interventions not only improve individual outcomes but also reduce the overall burden on healthcare systems, creating opportunities for actuaries to model more equitable longevity improvements across populations.

However, challenges such as algorithmic biases and unequal access to AI technologies must be addressed. Biases in training data can perpetuate or worsen existing disparities. Obermeyer et al. (2019) demonstrated that an algorithm used to allocate healthcare resources underestimated the needs of Black patients, leading to inequitable treatment allocation. Actuaries need to examine these biases in mortality models to ensure equitable assumptions across demographic groups.

In addition, AI's role in resource optimization can help identify and address geographic health disparities. Geospatial analysis using AI has been employed to map disease prevalence, such as cervical cancer hotspots, enabling targeted interventions in high-risk areas. Actuaries can incorporate such data into regional mortality assumptions, reflecting variations in access to AI-driven healthcare improvements.

LONGEVITY SHOCKS AND ACTUARIAL PREPAREDNESS

While addressing health disparities represents a key opportunity for AI, its ability to accelerate medical innovation also increases the risk of longevity shocks. These unexpected leaps in life expectancy present unique challenges for actuarial modeling and financial systems. Longevity shocks, or sudden and significant increases in life expectancy due to technological breakthroughs, pose substantial challenges for actuaries. Unlike gradual improvements in mortality rates, these shocks are difficult to anticipate and can disrupt financial systems reliant on stable mortality assumptions, such as pensions, life insurance, and annuities.

AI-driven medical advancements increase the likelihood of longevity shocks. As mentioned in Ouyang (2022), AI has accelerated drug discovery, reducing development timelines for certain diseases. Such advancements could lead to rapid improvements in treating chronic conditions and extend lifespans. AI's application in aging research, such as identifying senolytic drugs that target aging cells, raises the chances of delaying or reversing the aging process, as discussed in Sinclair (2019).

Longevity shocks present unique challenges for actuarial systems. Three illustrative scenarios are described below.

- In the Gradual Improvement scenario, a 5-year increase in life expectancy occurs over a 20- to 30-year period, driven by continued advancements in public health and healthcare access. Pension liabilities rise moderately as payout periods extend, while life insurance reserves require minor adjustments. This scenario aligns with historical trends and is manageable through periodic updates to mortality tables and funding assumptions.
- The AI-Driven Longevity scenario assumes a 10-year increase in life expectancy, fueled by breakthroughs in AI-enabled medical research, such as personalized medicine and early diagnostics. This accelerated improvement creates significant risks for pension systems, as liabilities grow rapidly and necessitate changes to retirement ages or contribution levels. For life insurance, reserves face substantial pressure due to longer benefit durations, requiring dynamic modeling techniques to reflect increased uncertainty.
- In the Extreme Life Extension scenario, a transformative 20-year increase in life expectancy occurs, driven by advances in aging science, such as cellular repair and genetic engineering. Pension systems face existential risks, with many plans becoming unsustainable without drastic reforms. Insurance reserves, particularly for annuities, fall critically short, as traditional pricing models fail to capture the extended payout periods. Preparing for such extreme outcomes requires actuaries to explore alternative scenarios, incorporate emerging longevity risks, and stress-test financial systems against unprecedented changes. Stochastic modeling may be used as well to simulate a range of potential outcomes, including extreme scenarios where AI-driven innovations extend lifespans dramatically.

These scenarios emphasize the need for actuaries to adapt their methods to account for varying levels of longevity risk. Actuaries must monitor developments in AI and biotechnology to detect early indicators of longevity shocks. By proactively adjusting assumptions and developing mitigation plans, actuaries can contribute to ensuring the long-term sustainability of financial systems.

THE PATH TO EXTREME LIFE EXTENSION?

AI's role in advancing aging research has fueled discussions about the potential for extreme life extension, where human aging processes are significantly delayed or reversed. Breakthroughs in cellular repair, genetic editing, and

AI-guided therapies could extend lifespans well beyond current expectations, challenging the traditional assumptions that underpin actuarial models.

For example, Sinclair (2019) describes how AI-enabled research has accelerated the discovery of therapies targeting the root causes of aging, such as cellular senescence and DNA damage. These advancements suggest a future where life expectancy is no longer constrained by biological aging, requiring actuaries to rethink mortality projections, retirement ages, and healthcare cost assumptions.

However, extreme life extension also raises ethical and societal questions. Access to life-extending technologies may be limited to wealthy populations, exacerbating health disparities. Beyond health equity, extreme life extension raises broader societal challenges, including intergenerational equity, resource allocation, and the sustainability of social support systems. Actuaries must consider these inequities when modeling future mortality trends, ensuring that projections account for variations in access to AI-driven healthcare innovations.

On the other hand, AI introduces risks that could shorten lifespans in some scenarios. Algorithmic biases, cyberattacks on AI-driven healthcare systems, and mismanagement of AI technologies could lead to systemic failures or unequal access to care. For example, a flawed algorithm could prioritize certain populations over others, limiting the benefits of life-extending interventions for marginalized groups (Obermeyer et al., 2019). Actuaries must incorporate such risks into their models, accounting for potential adverse outcomes alongside the benefits of AI advancements.

CONCLUSION

AI is transforming healthcare and longevity, presenting both opportunities and challenges for actuaries. By reducing health disparities, AI could narrow gaps in life expectancy, requiring actuaries to revise mortality assumptions and develop more equitable models. The possibility of longevity shocks, driven by AI breakthroughs, introduces uncertainty that necessitates dynamic tools such as stochastic modeling and scenario analysis. In addition, extreme life extension challenges traditional actuarial assumptions about finite lifespans, while the potential for life-shortening scenarios highlights the need for ethical safeguards and robust frameworks.

Actuaries are uniquely positioned to bridge technological advancements with financial sustainability. By adopting forward-looking methodologies and interdisciplinary collaboration, actuaries can ensure that financial systems remain resilient and adapt to AI's dual-edged impact on human longevity.

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REFERENCES

Heady, Denise (2024). “AI model may yield better outcomes for prostate cancer.” https://www.uclahealth.org/news/release/ai-model-may-yield-better-outcomes-prostate-cancer.

Obermeyer, Z. et al. (2019). “Dissecting Racial Bias in an Algorithm Used to Manage the Health of Populations.” *Science*, 366(6464), 447–453.

Ouyang, Alex (2022). “Artificial intelligence model finds potential drug molecules a thousand times faster.” https://news.mit.edu/2022/ai-model-finds-potentially-life-saving-drug-molecules-thousand-times-faster-0712.

Sinclair, D. A. (2019). “Lifespan: Why We Age—and Why We Don’t Have To.”

Topol, E. (2019). “Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again.”

Xu, Xinjia et al. (2023). “The application of artificial intelligence in diabetic retinopathy: progress and prospects.” https://pmc.ncbi.nlm.nih.gov/articles/PMC11543434/.

Yang, Rui et al. (2024). “Disparities in clinical studies of AI enabled applications from a global perspective.” https://www.nature.com/articles/s41746-024-01212-7.